Advait Mehla

✉ advaitmehla@iitb.ac.in
advaitmehla.github.io

Education

2020 – Present
Indian Institute of Technology Bombay, India
Bachelor of Technology in **Engineering Physics** (with Honors), Grade: 8.86/10
Pursuing a **Minor** in **Electrical Engineering**

Publications and Conference Proceedings

- Bala S., Mate S., **Mehla A.** et al., "Prospects of measuring gamma-ray burst polarization with the Daksha mission," J. Astron. Telesc. Instrum. Syst. 9(4) 048002 *(2023)*
- Bhalerao V., Sawant D., . . . , **Mehla A.** et al. "Science with the Daksha High Energy Transients Mission" (arXiv:2211.12052), under review in *Experimental Astronomy (2022)*
- **Mehla A.**, Dewangan G., et al. "All-sky Compton Imaging with the Daksha space mission". *Manuscript in preparation*
- Mate S., Sastry P., **Mehla A.** et al. "Hard X-ray Polarization measurement capability of Daksha", *Astrophysical Polarimetry in the Time-Domain Era*, Politecnico di Milano, Italy *(2022)*
- **Mehla A.**, Mate S., Dewangan G., Bhalerao V. "All-sky Compton Imaging with the Daksha space mission", *Poster accepted for the ASI 2024 Annual Meeting*
- Tendulkar S., **Mehla A.** et al. "Prospects of measuring gamma-ray burst polarization with the Daksha mission", *Poster accepted for the ASI 2024 Annual Meeting*

Research Experience

Nov 2021 – May 2023
Measuring the Polarization of Gamma-Ray Bursts with the Daksha mission
Guides: Prof. Varun Bhalerao (IIT Bombay), Prof. Shriharsh Tendulkar (TIFR Mumbai)

- Simulated the interactions of high-energy photons with the satellite mass model and detector readout using the GEANT4 toolkit to obtain realistic event files
- Obtained the background rates due to Cosmic X-ray Background and Earth albedo
- Developed a processing pipeline to implement Compton polarimetry with pixelated CdZnTe detectors using a χ^2 fitting-based template matching technique
- Determined the Minimum Detectable Polarization (MDP) of the mission through a novel Monte Carlo sampling method, estimating the detection rate for polarized GRBs

May 2023 – Sept 2023
Demonstrating Optimal Nonlinear Control in a Classical Experiment
Guide: Prof. Rana Adhikari, California Institute of Technology

- Designed and constructed low-noise analog circuits for temperature readout and pulse-width modulation (PWM) driven heater circuits for the control system
- Implemented a Raspberry Pi-based controller including data acquisition and actuation systems using a Waveshare AD/DA Board
- Created numerical models to simulate heat-transfer mechanisms for an insulated mass, and experimentally constrained free parameters
- Executed PID temperature control of a system and achieved simulated performance

Aug 2023 – Present
All-sky Compton Imaging with the Daksha space mission
Guide: Prof. Gulab Dewangan, Inter-University Centre for Astronomy and Astrophysics

- Integrated NaI scintillators into the mass model and emulated SiPM readout to generate realistic data with Poissonian timestamps and effects of spatial and energy resolution
- Implemented a Compton reconstruction algorithm to utilize coincident events between detector pairs and effectively localize sources in the sky and project them with HealPy

Awards and Achievements

- Among the **top 23** students worldwide to be awarded a fully-funded LIGO-SURF summer internship at the California Institute of Technology *(2023)*
- Awarded the MITACS Globalink Research Award for a summer internship at TRIUMF, Vancouver and the ANU Future Research Talent Award (both declined) *(2023)*
- Bestowed the Undergraduate Research Award by the Department of Physics, IIT Bombay for performing exceptional research *(2023)*
- Awarded a Branch Change to Engineering Physics on the basis of exemplary academic performance *(2021)*
- Ranked **959$^{\text{th}}$** nationwide among **1 million** candidates in the JEE Main exam *(2020)*
- Among the **top 450** students nationally selected for Indian National Physics Olympiad (INPhO), the second stage of qualifiers to the International Physics Olympiad *(2019)*
- Awarded the prestigious KVPY Fellowship by the Department of Science and Technology, Government of India twice with nationwide ranks of **466** and **306** *(2018, 2019)*

Workshops

December 2022 — **Radio Astronomy Winter School, NCRA-TIFR Pune**

Ten-day offline school consisting of talks and experiments on the fundamentals of radio astronomy

- Attended seminars by renowned experts on topics like radiative processes, techniques and instruments used, observational radio astronomy, cosmology and fast radio bursts
- Recorded observations of HI emissions at different longitudes in the galactic plane with a horn antenna and obtained a rotation curve for the Milky Way using redshifts

December 2022 — **GEANT4 and its Application to High-Energy Physics & Astrophysics, IUCAA Pune**

Five-day offline workshop on the applications of GEANT4 intended for graduate students

- Attended talks by prominent researchers working on various experiments like CMS, Hyper-K, POLAR, Fermi and AstroSat, learnt about the simulation techniques utilized
- Implemented detector systems like CMS-HGCAL and a scattering polarimeter from scratch during hands-on tutorials and analyzed resulting data using Python and ROOT

Other Projects

Spring 2023 — **Studying an Exoplanetary System with GROWTH-India Telescope (Report)**

Guide: Prof. Varun Bhalerao, IIT Bombay (Course: Observational Astrophysics)

- Submitted a proposal to observe a transit of exoplanet WASP-43b around its host star
- Reduced images to compute the relative flux evolution using `Astropy` and `Photutils`
- Fitted the observed transit data to a model using a Markov-Chain Monte Carlo method with the `exoplanet` package and inferred several parameters within 1σ of actual values

Autumn 2022 — **Resonant Mass GW Detectors : Instrumentation & Noise Sources (Report)**

Guide: Prof. Archana Pai, IIT Bombay (Course: Gravitational Wave Astronomy & Physics)

- Surveyed literature on the mechanics of resonant bar gravitational wave detectors, noise sources, measurement challenges involved and limitations of the technique
- Analyzed the electro-mechanical oscillator system and its transfer function to understand its advantages for the detection of gravitational waves
- Quantified the minimal detectable energy and noise spectral density of noise sources

May 2021 – June 2022 — **IIT Bombay Student Satellite Program**
Communication Subsystem, GLEE Project

- Designed a prototype PCB ChipSat capable of processing and wirelessly transmitting data from the lunar environment gathered by two sensors interfaced with a microcontroller
- Implemented UART and SPI communication protocols to achieve data transmission

Instrumentation Subsystem, GLEE Project

- Scrutinized components for and constructed a multi-stage analog readout circuit for a PIN diode based spectroscope to study solar flares on the lunar surface
- Verified the functioning of the circuit by injecting simulated input signals

Autumn 2023 **Speckle Imaging and Adaptive Optics**

Guide: Prof. Archana Pai, IIT Bombay (Course: Advanced Astrophysics)

- Discussed the method of speckle interferometry using Fourier transforms to obtain the power spectrum of the source, and demonstrated the technique with SOAR HRCam data
- Studied the working of adaptive optics systems and Shack-Hartmannn wavefront sensors
- Discussed key results from each technique, and compared their advantages and limitations

July 2021 - Sept 2021 **Simulating Asteroid Belt Dynamics**

Summer Project, Krittika: The Astronomy Club of IIT Bombay

- Implemented a Monte Carlo simulation to evolve large distributions of asteroids over millions of years to observe the emergence of features like Kirkwood gaps and Trojans
- Optimised simulation times by a factor of 6 to 12 via implementation of parallelized code using high performance computing libraries like OpenMP and CUDA Fortran

Autumn 2022 **Truly Random Number Generator using Chaos**

Guide: Prof. Pradeep Sarin (Course: Microcontroller Lab)

- Designed and built a chaotic Chua circuit tuned to operate in the double scroll region
- Interfaced the circuit with an Arduino and pre-processed the bitstream using the von Neumann whitening algorithm to de-skew them, proved randomness using rigorous tests

Autumn 2021 **Closed Loop Analog LED Controller**

Guide: Prof. Pradeep Sarin (Course: Op-amp Lab)

- Designed a P-Type Controller with a photodiode as input to maintain the intensity of an LED at a constant set-point in the presence of ambient noise
- Debugged and tuned the circuit parameters after implementing it on a breadboard using several operational amplifiers to achieve stable behaviour

Technical Skills

Languages Python, C/C++, Fortran, MATLAB, LaTeX, Embedded C

Packages Astropy, HealPy, Photutils, NumPy, Matplotlib, SciPy, SymPy, Pandas, Numba, PyMC

Others Git, GEANT4, OpenMP, CUDA, ROOT, LTspice, Photoshop, EAGLE, Arduino IDE

Positions of Responsibility

June 2022 – May 2023 **Manager, Krittika: The Astronomy Club of IIT Bombay**

Led a team of 15 to organize outreach and research events to propagate astronomy at IITB

- Handled a budget of INR 250k+ utilized to purchase telescopes, imaging equipment and to organize events such as trivia quizzes, visits to observatories for the student body
- Acquired approval for the development of the IIT Bombay Observatory with an initial funding of INR 2 million, currently spearheading the project
- Organized the Krittika Summer Projects – 10 week long mentored research projects in astronomy; received 100+ applications, international participation for the first time
- Hosted regular observing sessions with a reach of 1000+ students and staff members
- Introduced modern techniques like Electronically Assisted Astronomy to the club's arsenal

Spring 2023 **Teaching Assistant, PH 111: Introduction to Classical Physics**

- Responsible for tutoring 40 students, guiding them with coursework & solving doubts
- Ensured smooth conduction of course by acting as a point of contact between students and course instructors; graded assignments, exams and provided feedback to students

Autumn 2023 **Teaching Assistant, PH 435: Microcontroller Lab**

- Responsible for grading and assisting groups of 10+ students during weekly labs
- Advised teams for hardware projects, guided them with debugging and troubleshooting

Relevant Courses

Physics Observational Astrophysics, Advanced Astrophysics, Gravitational Wave Astronomy
General Relativity, Quantum Mechanics, Classical Mechanics, Statistical Mechanics
Thermal Physics, Electromagnetic Theory, Nuclear & Particle Physics, Photonics

Math Differential Calculus, Integral Calculus, Linear Algebra, Complex Analysis
Ordinary & Partial Differential Equations, Numerical Analysis

Computing Advanced Simulation Techniques in Physics, Image Processing, Machine Learning

Electronics Analog Lab, Op Amp Lab, Digital Electronics Lab, Microcontrollers Lab,
Digital Electronics, Signal Processing

Extracurricular Activities and Interests

- Captured several images of deep sky objects, the Milky Way and planets along with special astronomical events like comets, eclipses and meteor showers with basic equipment
- Skilled in processing raw data from professional sources like the HST, JWST; awarded NASA APOD for processing an image of the Trifid Nebula in 2022
- Featured multiple times on outreach pages of NASA and ESA for astrophotography
- Awarded a cash prize and an internship offer as sole winner out of 20+ teams in the Astronomy General Championship conducted by Nayam Innovations and Institute Technical Council, IITB
- Attended the 3-day Vijyoshi National Science Camp conducted at IISc Bangalore for facilitating interactions between KVPY Fellows and world-renowned researchers from various fields of science